Space Weather Technical Forecast

Issued on Thursday, 21 April 2022 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance X-flares (R3 Radio Blackouts), with further M-class flares (R1/R2 Radio Blackouts) likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity is currently Moderate with an M9.6 flare observed from AR2993 peaking 21/0159 UTC, and an M1.9 flare observed from far-side region AR2992 peaking at 20/1254UTC. Background flux is persisting at C2-C3, with five sunspot regions on the Earth-facing disc. AR2993 Ehi/Beta-gamma and AR2994 Eki/Beta in the northeast form a large complex of sunspots in the northeast disc, and despite some indication of decay in AR2994 form the main source of this ongoing activity. AR2995 Cho/Beta is moderately sized, but magnetically simple whilst the other two regions are smaller and less likely to produce significant flaring. A CME was observed leaving the Sun due to the M9.6 flare, however imagery for analysis has been limited. Current indications are that this is a weak CME, with a glancing arrival possible late on the 24th. However this will likely be updated once more imagery is available.

Solar Wind / Geomagnetic Activity: The solar wind speed as measured by ACE and DSCOVR at L1, has been slightly elevated at 400-430km/s. The density was below average at first, but steadily increased to be above average by midnight, reaching around 15ppcc. The magnitude of the Interplanetary Magnetic Field (IMF), Bt, was mostly weak below 8nT, with its north-south component, Bz, varying between +7/-6 nT. However Moderate IMF arrived just after 21/1100 UTC with Bz becoming southward at -8nT, along with density falling to background. Solar winds also started to slowly rise. This was potentially the arrival of any fast wind of CH76, a coronal hole that is no longer visible on the disc. The phi angle was generally positive (away from the Sun) but with some variability, until around 20/0800 UTC, when it became more persistently positive. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at Background levels throughout. The high energy electron flux (greater than 2MeV) reached High levels at the diurnal maximum, with 2030 pfu recorded at 20/1755 UTC, but dropped out to background after 20/2150 UTC. The corresponding 24-hour integrated electron fluence was on a steady trend, close to the Active threshold but has recently eased to just below. This reached a value of 7.46e7 integrated pfu at 21/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate over the next four days, with a chance of X-class flares (R3 Radio Blackouts), mainly from the large region in the northeast quadrant. There is on ongoing likelihood of isolated M-flares (R1/R2 Radio Blackouts)

Solar Wind / Geomagnetic Activity: The CME from the M9.6 flare has the potential to glance Earth on the 24th (day 4), however this is low confidence. Solar winds have the potential to be slightly elevated day 1 (21st), likely due to weak fast wind influence from CH76 which is no longer visible. These then easing to background, before the next coronal hole enhancement is possible day 4 (24th) from CH77. Geomagnetic activity is likely to Quiet with isolated Unsettled intervals, and a slight chance of Active intervals each day. Activity increasing to Unsettled to Active with a chance of G1 Minor storms, with any CME glance that occurs day 4 (24th),

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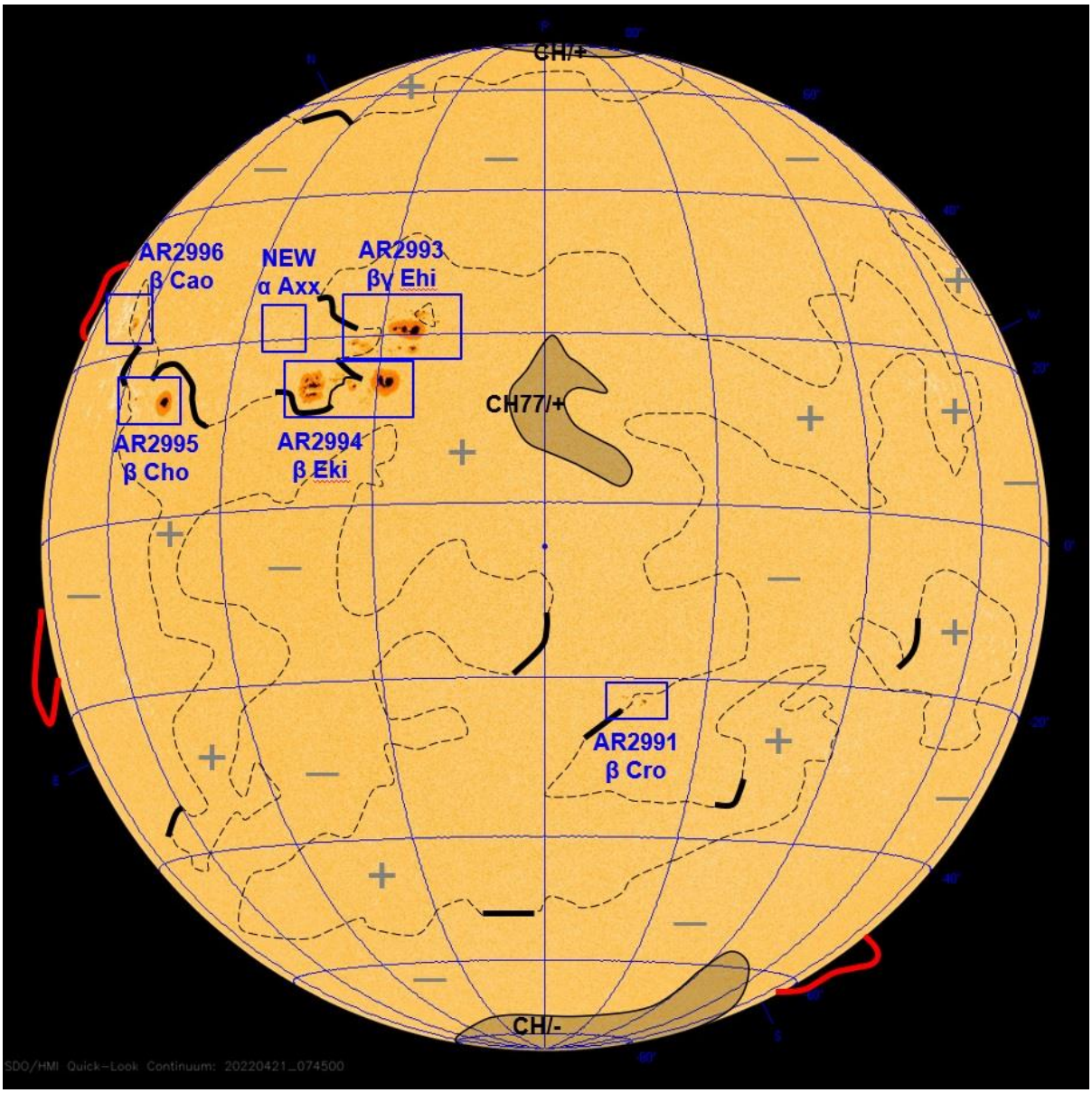
although this is currently low confidence.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the most complex regions rotate westward. The high energy (greater than 2 MeV) electron flux is currently at background, and whilst some recovery to Moderate levels is possible through the period, the associated fluence is now expected to remain below this level.

Figure 1. Solar Analysis Valid 21/0800.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME from the M9.6 flare has been assessed as likely passing to the north and behind Earth, but with a chance of a glancing interaction late on day 4 (24th). Although this assessment is low confidence at this stage as we await further imagery.

Solar winds have the potential for a slight enhancement day 1 (21st) due to any residual influence from vanishing coronal hole 76, which was present when in the centre disc, and shows some potential enhancement on STEREO A data which would coincide with arrival at Earth early on day 1 (21st). Coronal hole 77 is the next feature of note, but is much reduced and has retreated eastwards compared to the previous rotation, and as such is not expected to arrive until later on day 4 (24th).

Geomagnetic activity is likely to Quiet with isolated Unsettled intervals, and a slight chance of Active intervals each day. Activity increasing to Unsettled to Active with a chance of G1 Minor storms, with any CME glance that occurs day 4 (24th), although this is currently low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1429	Partial	M9.6 flare	19E16N (AR2993)	320	25/0000 UTC	Very low confidence – will be reanalysed with more imagery

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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Moderate after the impulsive M9.6 flare from AR2993 Ehi/Beta-gamma which peaked at 21/0159 UTC. Background flux has persisted at C2-3 post flare, slightly up from pre-flare levels and further activity is likely from either this spot, or its large companion AR2994 Eki/Beta. Together these form a large complex in the northeast disc, and produced an X1.1 flare on the 17th, with further C to M-flares following. Some slow decay has been evident in the trailer of AR2994, however these spots are currently only slowly evolving and have sufficient flux for further high M or X-flares (R2-R3 Radio blackouts).

There are five sunspot regions on the disc, including AR2993/AR2994. Two of these follow this complex. including AR2995 Cho/Beta which is a moderately sized region, with the potential for further development, and AR2996 Cao/Beta which is smaller and closer to the limb, leading to a more difficult and uncertain analysis. AR2991 Cro/Beta is the other smaller region, just west of the south centre disc and has been showing some slight growth in the last 12 hours.

Moderate activity is likely to continue through the period, with a daily slight chance of increasing to Strong due to the occurrence of any X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 2: GOES-16/17 X-ray Flux

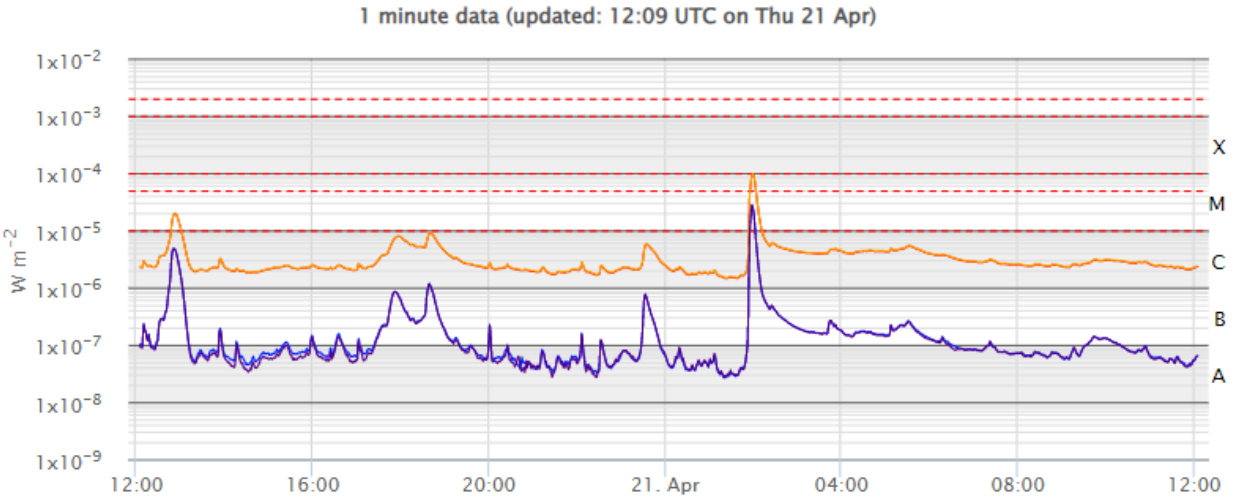

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Figure 3: SDO Intensitygram and Magnetogram of NE disc.

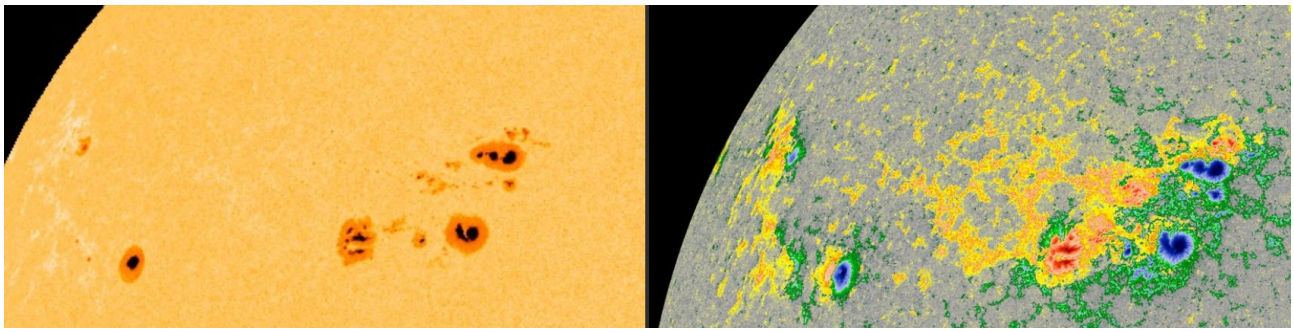
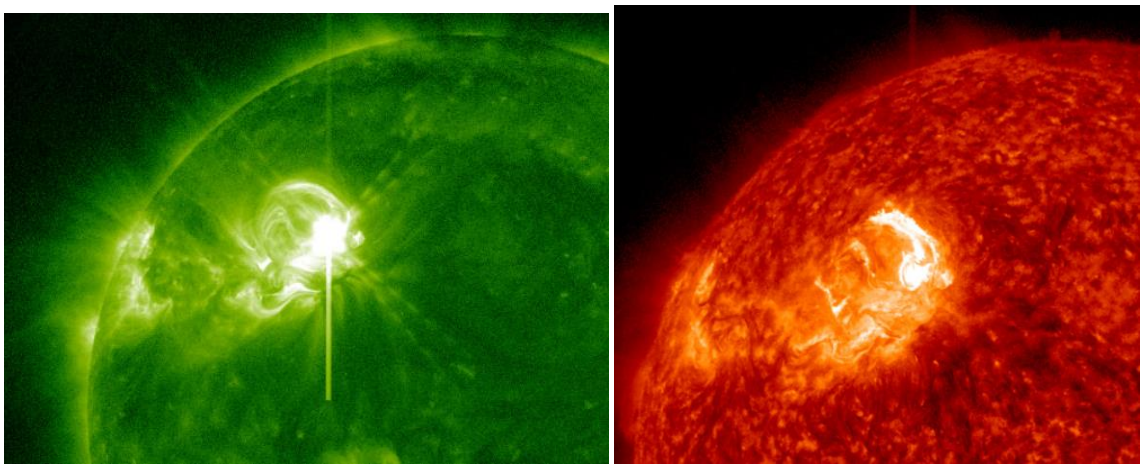


Figure 4: SDO aia-94(left) and aia-304 (right) showing M9.6 flare



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days.

AR2993 and AR2994 form a complex of sunspots across the northeast disc that is gradually rotating into a more geoeffective position for proton enhancement. Any notable flares from these regions have a slight, but increasing potential for proton storms to occur at Earth through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	7	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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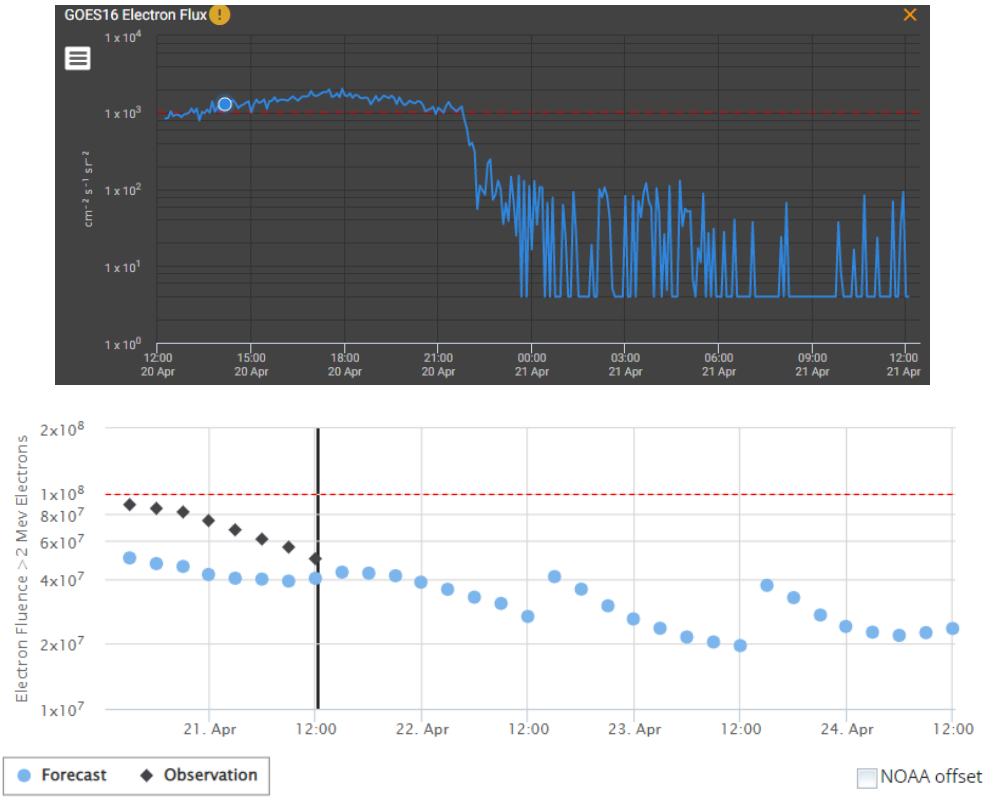
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO dropped out overnight, falling from high levels to background. A modest recovery is possible, with periods of Moderate flux, perhaps limited to diurnal maximums, but likely staying below the High alert threshold (1000 pfu)

The associated 24 hr electron fluence is below the Active threshold (1e8 total pfu), with a declining trend. This is supported by REFM, and with no notable flux enhancement expected, below Active fluence is expected throughout.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux and associated fluence with REFM



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